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TECHNOLOGICAL ADVANCEMENT IN REMOVING HEAVY METALS FROM INDUSTRIAL WASTE WATER

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ABSTRACT

Fluorides are important contaminants found in effluents from a variety of industries, including electroplating and glass. These are extremely harmful to living things and have a negative impact on their health. Thus, removing fluoride with biosorbents is an important step toward environmental conservation. The untreated discharge of industrial waste water into the environment has long had an impact on human, plant, and animal health. These effluents contain harmful compounds that are not degradable through chemical or microbiological processes. However, they are most likely to accumulate in soil, aquatic environments, and plant organs. The present work investigated the elimination of fluoride utilizing an aquatic plant species, Eichhornia Crassipes (Water Hyacinth) by the method of phytoremediation.

KEYWORDS: Fluorides, Biosorbents, Eichhornia Crassipes, Aquatic, Phytoremediation

INTRODUCTION

Due to recent rapid industrial growth and urbanization, the quality of the soil and ground water is deteriorating daily. Soil and water quality are being contaminated by the discharge of untreated industrial waste water and domestic house hold water into bodies of water. One of the primary environmental concerns in India is soil and groundwater pollution. Fluoride from industrial waste water can be treated using a variety of conventional techniques, including membrane filtration, precipitation, and nanofiltration. adsorption, flotation, electrocoagulation, ion exchange, and phytoremediation.

Growing in popularity, phytoremediation uses larger plants to clean up contaminated areas. It has a number of benefits over physical remediation techniques, one of them being its cheaper cost. Using green plants directly to stabilize or absorb pollutants from soil and water is known as phytoremediation. The processes of phytoextraction, rhizofiltration, phytostabilization, and phyto-transformation/degradation are all part of phytoremediation. The current research, which addresses the removal of fluoride from industrial waste water, takes all of these issues into account.

Background & Fluoride Toxicity

The reduced form of fluorine when it is an ion and when it is bound to another element is called fluoride, or anion F. Fluorides can refer to both inorganic fluorine-containing chemicals and organo fluorine-containing compounds. Like other halides, fluoride has a single charge (monovalent). Compared to other halides, its compounds frequently have unique features. The fluoride ion is structurally similar to the hydroxide ion, as well as somewhat chemically.

The dangerous inorganic contaminant fluorides is frequently present in subterranean water and industrial waste water. Fluoride concentrations below allowable levels are safe and healthy, but consuming fluoride at higher concentrations can be extremely harmful. Numerous organizations, including the USEPA, WHO, and CPCB, have established a tolerance range of 0.5-1.5 mg/l for fluoride concentrations in drinking water. Approximately one million individuals in India suffer from native fluorosis.

On skeletal tissues, fluoride can potentially have greater detrimental consequences. Drinking water with 3 mg of fluoride per litre has been linked to skeletal fluorosis, which is characterized by detrimental alterations in bone structure. In areas where drinking water contains more than 10 mg of fluoride per litre, crippling skeletal fluorosis develops. According to the US Environmental Protection Agency, skeletal fluorosis can be prevented at concentrations up to 4 mg/litre.

Origin of Fluoride

International

There have been reports of high fluoride concentrations in drinking water from almost every region in the world. The three continents most impacted are Asia, Africa, and North America. High fluoride concentrations have been documented in China, India, and Sri Lanka. High fluoride concentrations have been documented in the African Rift Valley countries as a result of alkaline volcanic rocks weathering.

India

Over time, higher fluoride concentrations have been found in various groundwater sources in India. This could be brought on by declining water tables, excessive water withdrawal, insufficient replenishment of subsurface aquifers, or any combination of these. In India, consequences of fluoride poisoning have been reported in 17 of the 28 states.

Water Hyacinth

Water hyacinth belongs to family Pontederiaceae of kingdom Plantae. It is a free-floating plant on the surface of water. To help it float it has spongy structures in its stems. The leaves of the plant are thick and the roots are very hairy. The roots work as a medium to filter water.

Water hyacinth supports the phytofiltration mechanism of phytoremediation. In phytofiltration, pollutants present on the surface of the water are trapped in the hairy roots, and thus the movement of the pollutant is stabilized so that it will not further contaminate the water. Phytofiltration is also known as rhizofiltration. Heavy metals from water are effectively removed by rhizofiltration because the heavy metals come directly in contact with the roots, which absorb heavy metals such as chromium, nickel, arsenic, and lead.

Figure 1 Eichhornia Crassipes

MATERIALS & METHODS

The aquatic creeper, Water hyacinth, sometimes known as water hyacinth, was chosen in order to evaluate its ability to remove fluoride from water in a lab setting. The world-wide perennial fresh and marine water weed Ipomoea Aquatica L. completes its life cycle as a free-floating plant, with the exception of its fully submerged root system. This species exhibits substantially higher metal-accumulating capacity than non-hyperaccumulating terrestrial plants, absorbs metals from water, and develops an internal concentration many times greater than their surroundings. As a result, this plant was chosen for the current study on phytoremediation. The fluoride concentrations were determined using a spectrophotometer.

Sample Collection

Location: This study was conducted at Bundelkhand Institute of Engineering and Technology, Jhansi, Uttar Pradesh, India

Figure 2 Collecting Plant from Lakshmi Taal, Jhansi

Figure 3 Stored plant from pond

Preparation of Hoagland Solution:

Hoagland solution is a hydroponic nutrient mixture first formulated by D.R. Hoagland and later revised by D.R. Arnon in 1950, having originally been developed in 1938. It remains one of the most popular nutrient solutions used for soilless plant cultivation due to its comprehensive nutrient content, which supports the growth of a wide range of plant species. The Hoagland solution is made up of three primary components:

1. Macronutrients
2. Micronutrients
3. Phosphate

The preparation of Hoagland's solution begins with the precise weighing of the required compounds on a scale. These compounds are then used to create stock solutions, which are stored in separate containers. Approximately 800 ml of distilled water is added to each of these components, and the mixture is then brought up to a total volume of 1 liter in a volumetric flask. The solutions are thoroughly shaken and mixed, rendering the Hoagland solution ready for use.

Figure 4 Before Washing and cleaning the plant

This solution is particularly beneficial for cultivating plants that require minimal nutrient inputs. Typically, for plants like Eichhornia crassipes, also known as water hyacinth, a concentration ranging from 10% to 20% of the Hoagland solution is sufficient. This tailored concentration ensures that the plants receive the optimal amount of nutrients necessary for healthy growth without soil, leveraging the solution's balanced nutritional composition. Here we used 10% of the solution for our investigation. Table1 shows various constituents and their concentration in Hoagland's solution.

Figure 5 After Washing and cleaning the plant

Components	**Stock Solution (g/L)**	**ML stock solution per litre**
Macronutrients		
2M KNO_2	202	2.5
1M Ca $[NO_3]_2$.4$H_2$0	472	2.5
Iron [Sprint 138 iron chelate]	15	1.5
2M $MgSO_4$.7 $H_2$0	493	1
1M NH_4NO_3	80	1
Micronutrients		
H_3BO_3	2.8	1
$MnCl_2$.4 $H_2$0	1.81	1
$ZnSO_4$.7 $H_2$0	0.22	1
$CuSO_4$.5 $H_2$0	0.051	1
H3MoO_4. $H_2$0	0.09	1
Na2MoO_4.2 $H_2$0	0.12	1
Phosphate		
1M KH_2PO_4	136	0.5

Table 1: Hoagland Solution Constituents

Figure 6 After Completing Experiment

Result and Discussion

Contact Time (Days)	**Initial Concentration of Fluoride (mg/l)**	**Absorbance of sample prepared (Ax)**	**Final Concentration of Fluoride (mg/l)**	**Amount absorbed by Eichhornia crassipes (mg/l)**	**% Removal**
0	15	0.3	15	0	0
1	15	0.28	14.3	0.70	4.70
2	15	0.26	13.70	1.30	8.70
3	15	0.24	13.10	1.90	12.70
4	15	0.22	12.50	2.50	16.70
5	15	0.20	11.90	3.10	20.70
6	15	0.18	11.40	3.60	24.0
7	15	0.16	10.90	4.10	27.30
8	15	0.15	10.70	4.30	28.70
9	15	0.14	10.50	4.50	30.9
10	15	0.13	10.40	4.60	30.70
11	15	0.12	10.35	4.65	30.40
12	15	0.11	10.30	4.70	30.04
13	15	0.10	10.27	4.73	30.01
14	15	0.95	10.22	4.78	30.08
15	15	0.90	10.20	4.80	30.09

Table 2 - Variation Of Contact Time on removal of Fluoride

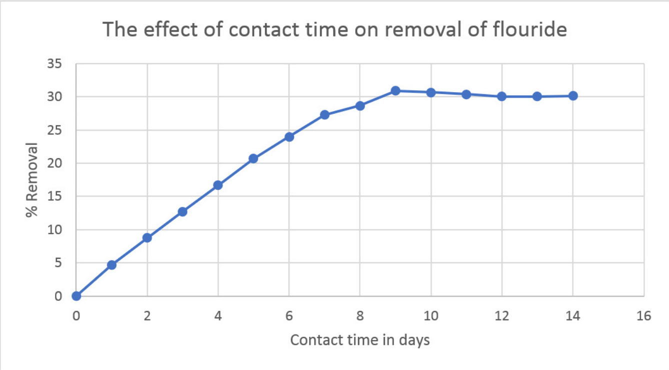

Figure- Effect of contact time on removal of Fluoride

CONCLUSION

- we investigated the efficacy of phytoremediation, particularly focusing on water hyacinth, in treating wastewater contaminated with fluoride (F).
- Our observations indicate that fluoride accumulation in Eichhornia Crassipes follows the pattern of roots > stem > leaves. Surprisingly, altering the pH of the system yielded unexpected results: regardless of pH increases or decreases, fluoride removal efficiency decreased.
- starting with an initial fluoride concentration of 15 mg/l, we observed a decrease to 10.20 mg/l after 15 days, resulting in the removal of 4.80 mg/l of fluoride. This translates to a successful removal rate of up to 30.09% of fluoride from the wastewater within the specified timeframe.

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